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BEECH INFRARED SUPPRESSION SYSTEM.(U)  
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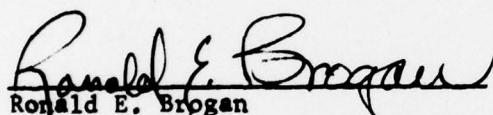
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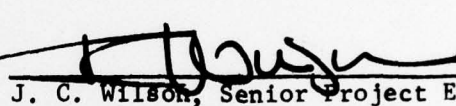
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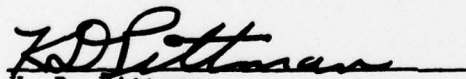
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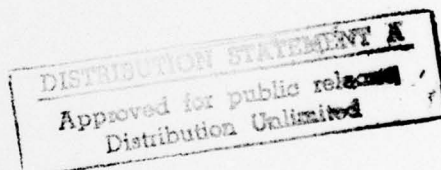
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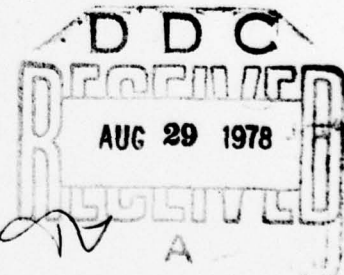
  
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## BEECH INFRARED SUPPRESSION SYSTEM

### INTRODUCTION

#### Scope

This Final Report is prepared in accordance with Contract DAAJ01-69-A-0313-0055, DD 1423, Sequence No. A006, DI-S-1800. The data provided herein pertains to Beech's effort in the development, testing and qualification of an infrared suppression system for U-21 series aircraft.

#### Intent

The intent of this report is to provide a summarization of the development, manufacture, qualification testing and delivery of Beech's 90-095004 Infrared Suppression System Installation. Technical Qualification Data is contained in Beech Engineering Report ER 90E486

### DISCUSSION

#### System Design, Manufacture

The Beech Infrared Suppression system was designed for use on Beech U-21 and RU-21A, D, E and H aircraft. The design approach was to cool the exhaust duct with ram air that is directed with a flow controlling shroud. In addition to directing the air flow, the shroud and associated flow splitter serves as a mask to shield the exhaust duct and plume from view. (See Figure 2, Page 6).

The major components of the Beech IR Suppression system (See Figure 1, Page 5) are:

- a) 90-950003-1 - Exhaust Stub. The main difference between the IR Suppression exhaust stub and the standard U-21 stub is in the shape. The standard U-21 stub protrudes perpendicularly from the engine exhaust port, turns aft slightly and terminates. The 90-950003-1 stub extends aft approximately 12.7 inches from the center of the exhaust port. As the stack sweeps aft, the 6.44 port diameter flattens to a blunt aft termination section of 9.9 (vertical axis) by 3.5.

The 90-950003 exhaust stub is a welded assembly made of .040 thick 18-8 cres. steel sheet per MIL-S-6721. The engine exhaust port attachment flange is a standard 50-950097-13, U-21 flange. The final assembly is pickled and passivated per Beech Standard 4692.

DISCUSSION - (Continued)System Design, Manufacture - (Continued)

- b) 90-950018-1 - (LH) -3 (RH) - Fairing Assembly. The fairing shape is roughly tubular with slightly flattened sides. The part is 37.2 inches long, with much of the vertical cross-section measuring 12.5 inches. The forward 10.9 inches converges to form an approximate 8.5 inch diameter inlet opening. The forward edge of the fairing is located approximately 5.2 inches aft of the forward edge of the engine cowl. The forward convergence of the part, with the 90-950017-1 (Para. C) inlet fairing in place, serves to fully block the 90-950003-1 exhaust stub from forward view. The fairing is attached to the nacelle with metal clips.

The 90-950018 - Fairing Assembly is fabricated, mostly, from 5-ply of # 181 glass cloth with resin per MIL-R-9299. 1.5 wide, .020 18-8 cres. steel stiffeners are laminated into the top and bottom edges to add attachment strength. The forward opening is further reinforced using a, laminated in place, section of fiber flex rope. The rope adds an approximate .4 bead around the inlet opening.

- c) 90-950017-1 - Inlet Fairing. The inlet fairing is a split-bullet shape 7.3 inches long with an aft diameter of 5.0 inches. Approximately .75% of the fairing's 7.3 inch length is nestled inside the 90-950018 fairing. The inlet fairing serves as an air flow splitter and shields the 90-950003-1 exhaust stub from forward view. Attachment is per small clip angles.

The inlet fairing is fabricated from 5-ply of #181 glass cloth with resin per MIL-R-9299.

- d) 90-095004-31, -32, -35, & -36 Deflector Assemblies. Each deflector assembly consists of three aft swept exhaust deflectors evenly spaced on a 13.00 x 2.1 inch doubler. The deflector assemblies are mounted just aft of the exhaust stub opening, about 7.2 inches apart and converge aft to 1.4 inches apart. The deflector vanes sweep aft and to the center. The deflector assemblies are completely enclosed, from side view, by the 90-950018 fairing assembly.

The doublers are fabricated from .040 thick 2024-T4 aluminum alclad sheet.

The deflector vanes are made of .063 thick cres. steel sheet, formed, then heat treated to 150,000 - 180,000 psi per MIL-H-6875.

DISCUSSION - (Continued)System Design, Manufacture - (Continued)

Individual component and total system weights data are given in Table I, below:

TABLE I

Item	Actual Weight (ea)	H-Arm	H-Moment
Exhaust Stub	4.64	68.0	315.5
Main Fairing	4.23	77.9	329.5
Inlet Fairing	0.53	63.2	33.5
Deflector Assy	2.40	87.5	210.0
Brackets and Hardware	0.28	78.0	21.8
Total Weight per Engine Side (Added Parts)	12.08	85.3	910.3
Parts Removed per Engine Side	-3.50	68.0	-238.0
Total Engine Side Weight	8.58	-	672.3

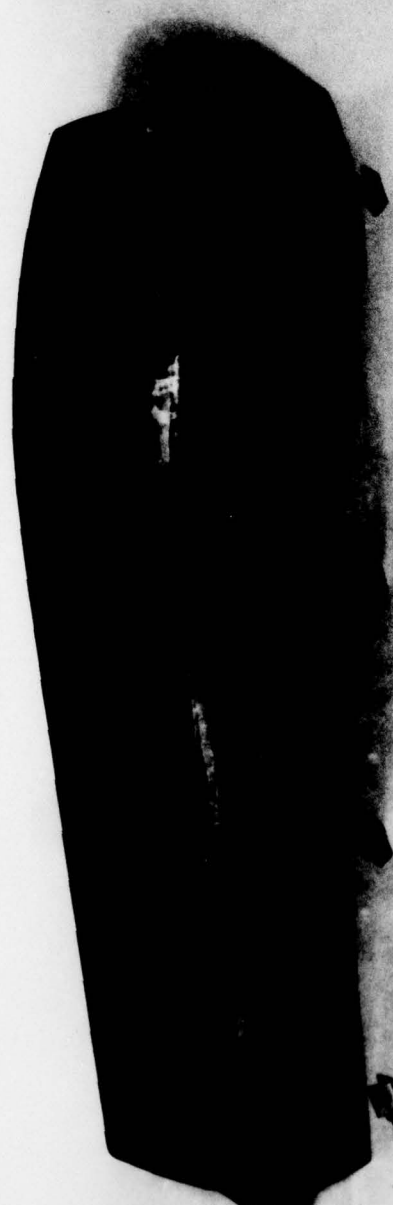
The total weight penalty for the Beech infrared suppression system is 34.32 pounds per aircraft.





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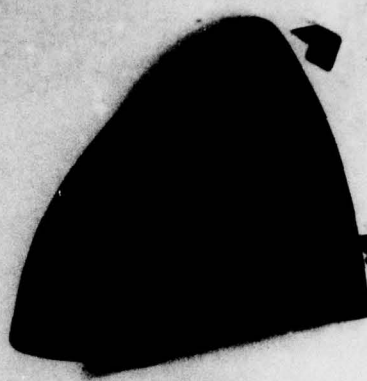
90-950018 - Fairing Assembly



Typical Attachment Clip



90-950003 - Exhaust Stub



90-950017 - Inlet Fairing

- 90-095004-31 (Upper, Left Engine Side)  
-32 (Upper, Right Engine Side)  
-35 (Lower, Left Engine Side)  
-36 (Lower, Right Engine Side)  
Deflector Assembly



FIGURE 1

I.R. Suppression Components  
for One Engine Side





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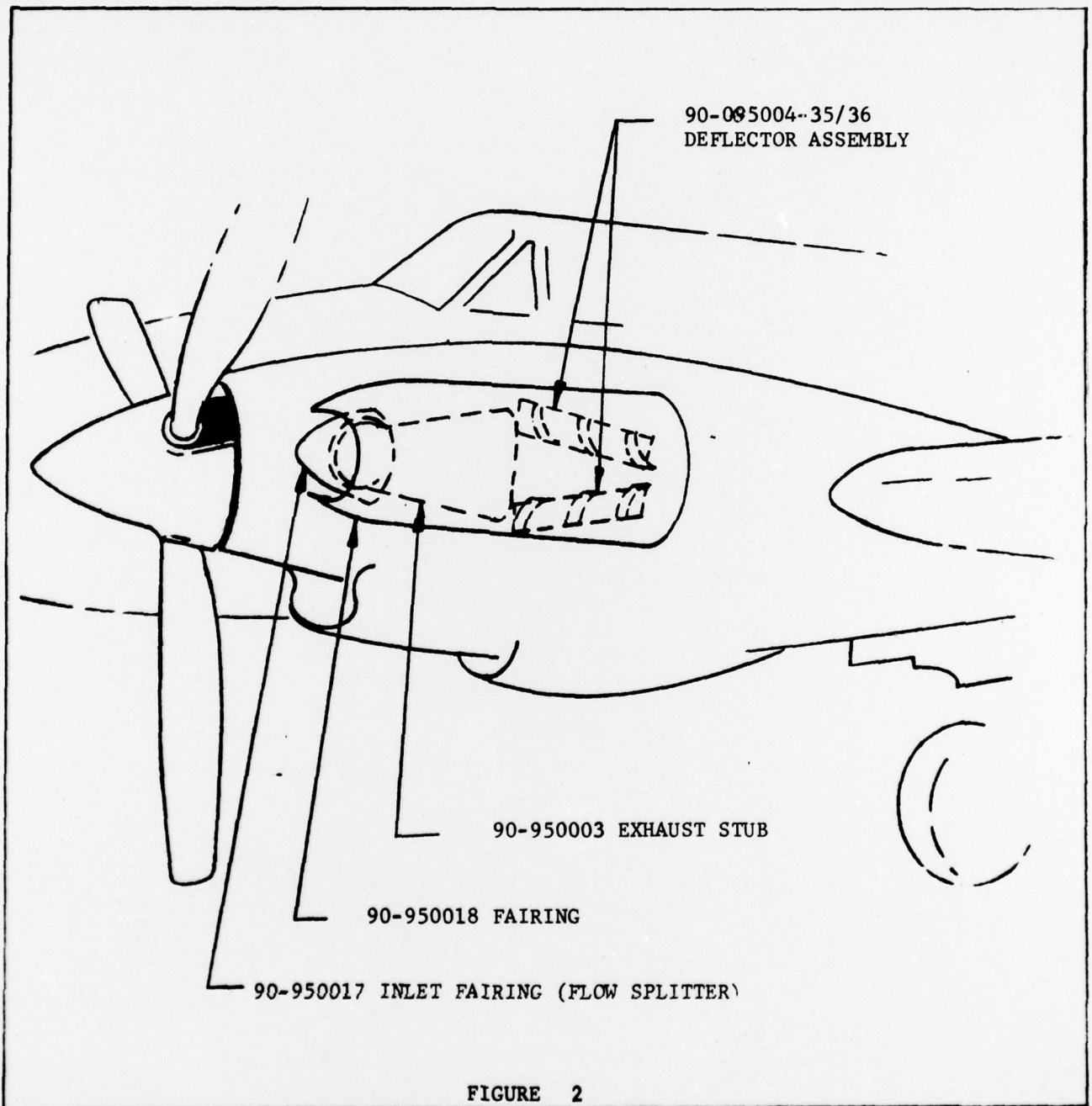


FIGURE 2

SKETCH OF 90-095004-1 INFRARED SUPPRESSION SYSTEM  
INSTALLATION ON U-21 AIRCRAFT.



DISCUSSION - (Continued)

Qualification Testing and Data

Airworthiness Qualification Data available at date of writing consists entirely of analytical and bench test results. No flight testing has been done.

Beech Engineering Report 90E486 presents Qualification Study Data for the Beech IR Suppression system. The report was prepared in accordance with Data Item DI-E-1134 of DAAJ01-69-A-0313-0054 and covers three areas: (1) System surveys, (2) Weight and Balance, (3) Handling qualities. Results of the study as given in 90E486 are summarized below:

- a) System Surveys. - Surveys included structural, vibration fatigue and flutter.

A structural analysis of the stack, shrouds, baffles and their attachments indicates that the system is structurally adequate with high margins of safety.

Vibration evaluation was based on more than 1,000,000 cycles of 10 G vibration testing the 90-950003 exhaust stub. After an early failure of some louvers, the louvers were removed and testing was completed without further failure.

Fatigue and flutter evaluation was based on results of vibration tests. Fatigue life for the parts is considered high, to unlimited. No flutter problem is anticipated or considered possible.

- b) Weight and balance data is shown in Table 1, Page 4.
- c) Flight and handling qualities, Table II, below, summarizes the effects of the Beech IR Suppression system on U-21 performance. The performance degradations are not of significant enough magnitude to affect any requirements set by the FAA.

DISCUSSION - (Continued)Qualification Testing and Data (Continued)TABLE II

Estimated Performance Reductions, U-21 Aircraft with  
Beech IR Suppression System Installed

Condition	Standard U-21A (U-21A-68-13)	U-21 Est./w IR Instl.	% Reduction
Max Endurance (No reserve, 5-min. allowance) 500 ft. Alt. ISA	7.15 hr.	6.86 hr.	4
Max Endurance (No reserve, 5 min. allowance) 25,000 ft. Alt ISA	8.68 hr. Includes 27.5 min. climb time	8.14 hr Includes 27.5 Min Climb time	6
Max Range, with 2000 lb. cargo (25,000 ft alt., 99% max Sr, 2120 lb fuel, -30 min reserve - ISA)	1056 NM	1009 NM	5
Optimum Ferry Range (25,000 ft Alt, 99% Max Sr, 30 min reserve ISA)	1456 NM	1356 NM	6
Mission Radius	368 NM	350 NM	5
Cruising Speed @ 10,000 ft	213 KTAS	205 KTAS	4
Cruising Speed @ 10,000 ft (99% Max Sr, 9650 lbs - ISA)	177 KTAS	177 KTAS	*
*NOTE: No change in speed, but fuel flow increase results in a reduction of specific range of 4%			
Cruise Airspeed @ 25,000 ft (9650 lbs ISA)	184 KTAS	170 KTAS	8
Single Engine R/C -SL 9650 lb ISA -5000 ft 9650 lbs ISA	500 ft/min 370 ft/min	430 ft/min 295 ft/min	14 20
Service Ceiling - ISA 9650 lbs - 100 ft/min -two engine -single engine	26,150 ft 12,000 ft	25,200 ft 10,000 ft	4 17

DISCUSSION - (Continued)Qualification Testing and Data (Continued)

Engine test stand testing (at UACL) will be required in order to determine the effect of the IR Suppression system on engine power available. Beech recommends this testing be performed and is taking steps with UACL to schedule the tests.

Beech is not presently under contract to perform or assist in actual IR Suppression tests.

DELIVERY

One aircraft set of Beech IR Suppression system hardware, as defined on Beech Drawing 90-095004\*, was transferred to the Beech GFE custodian on March 26, 1975, via DD 250 BEA 001. As of the date of writing the Beech GFE Bondroom has possession of the parts.

\*NOTE: One aircraft set consists of:

4 ea	90-095003-1	Exhaust Stubs
2 ea	90-950018-1	RH Fairing
2 ea	90-950018-3	LH Fairing
4 ea	90-950017-1	Inlet Fairing
1 ea	90-095004-31	Deflector Assy
1 ea	90-095004-32	Deflector Assy
1 ea	90-095004-35	Deflector Assy
1 ea	90-095004-36	Deflector Assy

A/R Miscellaneous attachment angles and hardware.

CONCLUSIONS AND RECOMMENDATIONS

Beech Aircraft Corporation has designed, manufactured, qualification tested and delivered IR Suppression system hardware in accordance with DAAJ01-69-A-0313-0055.

Based on the results of Airworthiness Qualification Study, results detailed in Beech Engineering Report 90E486, and summarized herein, Beech recommends installation and flight test of the 90-095003-1 IR Suppression system on U-21 aircraft.